The LOCOMOTIVE WORLD

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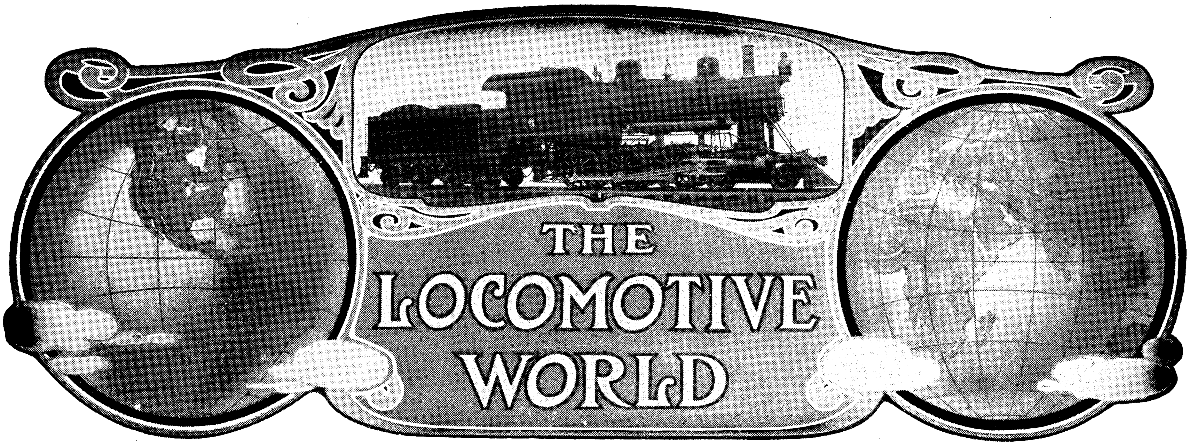
INDUSTRIAL AND
STANDARD RAILROAD MOTIVE POWER



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THE LOCOMOTIVE WORLD

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RATING OF A LOCOMOTIVE

IN rating a locomotive, it is customary among the builders to refer to size cylinders and average weight in working order. However, some few users may speak of locomotives as certain horsepower. This was no doubt taken from foreign locomotive engineers, as it would be difficult to understand where such an expression could have originated from any American locomotive builder or reference books on American locomotives. It is true that stationary engines are rated by horsepower, but a stationary engine differs from a locomotive in as much as the engine is stationary and it is possible to calculate that it can run at certain stipulated revolutions per minute and thereby develop certain horsepower. With the locomotive it is being run at various speeds, according to load hauled, conditions of road, etc., which would make it impossible to rate the locomotive in this manner with any degree of accuracy. In calculating approximately the indicated horsepower developed by a locomotive, the following well known formula is used:

$$\frac{P\ L\ A\ N}{33{,}000} = \text{HP. and}$$

$$\frac{\text{Tractive Power} \times \text{Speed}}{375} = \text{HP.}$$

For the benefit of those who may be interested we give an example, P, L, A, N, represent the following terms or figures and are to be multiplied together and divided by 33000:

P = Mean effective pressure in cylinders.
L = Length of stroke in feet.
A = Area of piston in square inches.
N = Number of strokes per minute.

In order to find the value of P without indicator, we must first determine the number of revolutions the drivers will make per minute at the speed given. Suppose it is desired to know the horsepower of a locomotive running twenty miles per hour, size of locomotive, cylinders 15 inches, diameter 20 inches stroke,

boiler pressure 180 pounds, drivers 44 inches diameter. The number of revolutions the drivers will make is found by finding the circumference in feet or inches and dividing in into the number of feet or inches in one mile, as follows: $44'' \times 3.1416 = 138.1340''$ = Circumference.

For the sake of simplifying the calculation we will eliminate the fractions and call it 138 inches. Then $5280 \times 12 = 63360$ inches and $63380 \div 138 = 460$ revolutions per mile.

Then if the locomotive is running at the rate of one mile per minute, the drivers would revolve at the rate of 460 revolutions per minute but as it is running 20 miles per hour or sixty minutes, the drivers will revolve twenty sixtieths of 460 in one minute.

$20 \times 460 = 9200 \div 60 = 153$ revolutions at twenty miles per hour.

By data obtained in a large number of tests it has been possible to approximate closely the mean effective pressure in the cylinders at various speeds in percentage of boiler pressure, and by this method find that at 153 revolutions per minute the mean effective pressure would be equivalent to 52 per cent. of the boiler pressure. We then have:

$180 \times .52 = 93.6$ pounds M. E. P. Therefore 93.6 equals the value of P.

We do not wish to convey that 52 per cent of the boiler pressure will give the Mean Effective Pressure at all speeds as it will not, but would state that according to the data obtained in various tests above mentioned it has been determined approximately that at fifty revolutions of the drivers per minute, the mean effective would be equivalent to 90 per cent. of the boiler pressure; 75 revolutions per minute 82.5 per cent; 100 revolutions per minute 72.5 per cent; 125 revolutions per minute 62.5 per cent; 150 revolutions per minute 55 per cent· 175 revolutions per minute 45 per cent; 200 revolutions per minute 37.5 per cent; 225 revolutions per minute 32.5 per cent.

Consequently, should it be desired to make calculations at various speeds, the Mean Effective Pressure can be approximated by these figures.

To find the value of L in feet, divide the length of the stroke in inches by 12; thus $20'' \div 12 = 1.66$ or 1 2-3 feet.

To find the value of A, square the diameter and multiply by .7854; thus $15 \times 15 \times .7854 =$ 176 plus square inches and equals A.

To find the value of N, find the number of revolutions per minute and multiply by 2, as the piston makes two strokes in each revolution of the drivers. In the above calculations we have found that the drivers make 153 revolutions per minute; therefore $153 \times 2 = 306 =$ number of strokes per minute and equals N.

We have found the value of the letters, and substituting known quantities for the letters, we have the following:

$$\frac{93.6 \times 1\text{-}\tfrac{2}{3} \times 176 \times 306 = 254.5 \text{ or } 255.}{33000}$$

which is the indicated horsepower developed in one cylinder, and $255 \times 2 = 510 =$ horsepower of both cylinders at twenty miles per hour.

In the second formula stated, viz:

$$\frac{\text{Tractive Power} \times \text{Speed}}{375} = \text{H.P.}$$

we must find the tractive power. This is found by the well known formula as follows:

$$T = \frac{d^2 \times s \times p.}{D}$$

Where T = Tractive Power
d^2 = Diameter of Cylinders in inches
s = Length of stroke in inches
D = Diameter of drivers in inches
$p = 85\frac{1}{2}$ of working pressure of the boiler.

The only change it will be necessary to make in this formula is in the last letter "p" which in the above calculations we have found to be 52 per cent. This difference is accounted for by the reason of the fact that in calculating the tractive power of a locomotive 85 per cent. of the boiler pressure is commonly used. This gives the maximum tractive power at slow speed, whereas, in these calculations it is desired to find porsepower at twenty miles and we all know it is not practical to operate a locomotive at full stroke of the piston at 20 miles per hour.

Now, substituting valves in our tractive power formula, we have the following:

$$\frac{15 \times 15 \times 20 \times 93.6}{44} = 9572.$$

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LOGGING IN MAHOGANY FORESTS

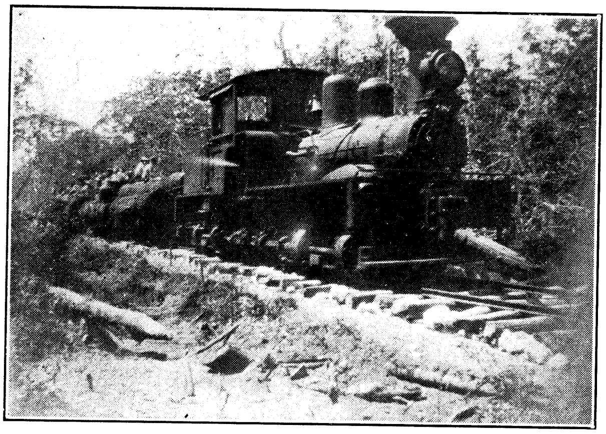
THE value of mahogany, a familiar dark colored wood largely used for household furniture, and supplied by a large tree indigenous to Central America, was first noticed by a carpenter on board Sir Walter Raleigh's ship in the year 1595. Its use, however, as a cabinet wood was first practically established by a cabinet maker named Wallaston, who was employed by Dr. Gibbons, to work up some of this wood which was brought to England by his brother. This was in the early part of the eighteenth century.

Since its introduction, no wood has been used more generally for cabinet making purposes and none possess like advantages of combined soundness, large size, uniform grain, durability, beauty of color and richness of figure. In the trade the wood is generally classified under two heads, i. e. Spanish mahogany and Honduras mahogany or baywood. The original Spanish mahogany is the

SCENE ALONG THE RAILROAD, C. C. MENGEL AND BROTHER COMPANY'S OPERATIONS IN CENTRAL AMERICA

production of San Domingo, whence only a small supply comes and mostly in logs of not more than 8 to 10 feet long by 12 to 13 inches thick. However, the Honduras logs are sometimes obtained 40 feet long and 2 feet or more in thickness. It appears that the wood obtained in the North portion of Honduras near the Mexican border is much longer and of a better quality than that which is obtained in the swampy lands.

To log in a mahogany forest is a much different proposition than operating in the forests of our native land. Many obstacles have to be overcome. The wood-tick, which is common to Central America, is a pest of the Honduras forests. The climate is hot and damp and were it not for the trade winds, the heat would be extreme. Notwithstanding these objections men from the United States have invaded these forests with modern and up-to-date methods which facilitate the production of the famous wood, mahogany. Little do we think of the difficulties encountered in pro-

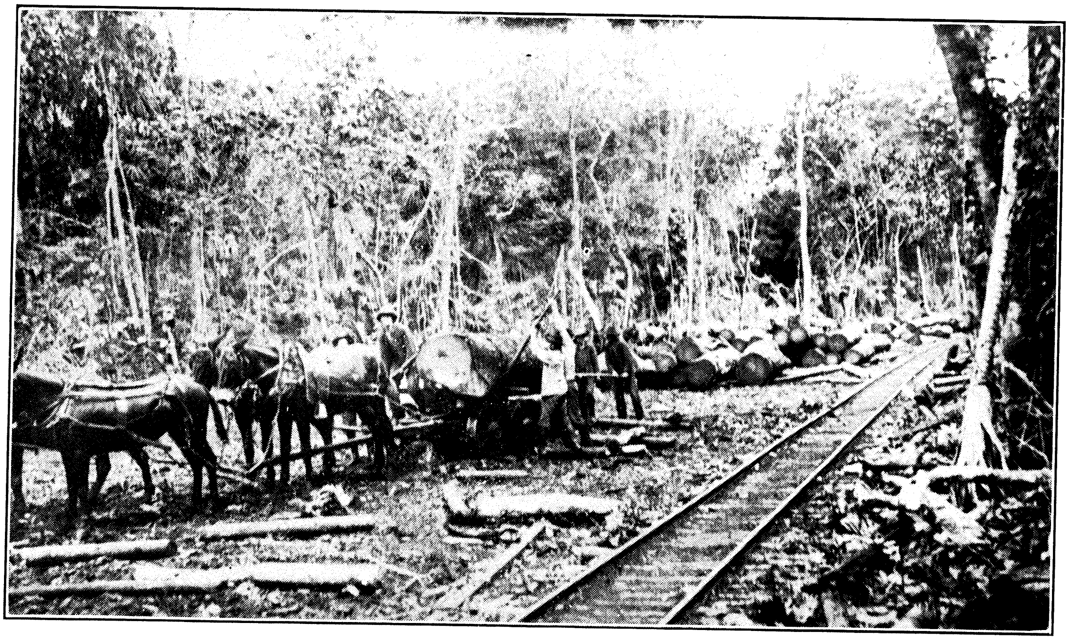


LOG TRAIN CROSSING THE ARECHA NEAR STATION NO. 5,
C. C. MENGEL AND BRO. CO. RAILROAD

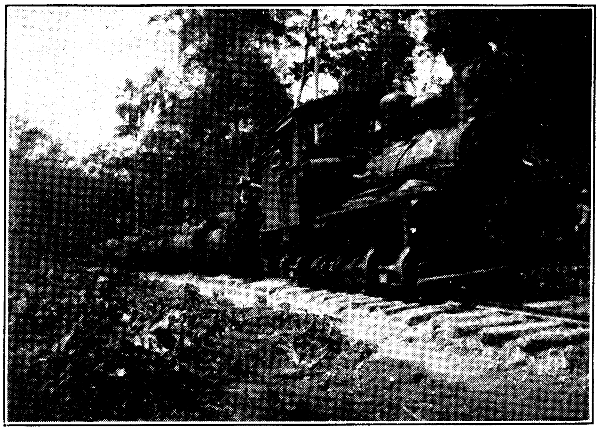
curing this fine wood when we sit in our homes enjoying the best that money can buy. Some of the mansions in the cities are finished entirely in solid mahogany. However, much of the furniture that is now placed on the market is veneered, which enables the maker to produce the fine, rich, colored finish, at the same time stretch out the supply of the wood to many times what it would be if the entire piece were solid.

To give the reader some idea of a British Honduras forest in operation, we show the views taken in the operation of C. C. Mengel & Brother, Belize, British Honduras. This concern, whose home office and factory are located in Louisville, Ky., is among the few who have attempted operations on a large scale.

Their operations are in the north portion of British Hondurus near the Hondo river and their holdings extend into Yucatan. They have a 36″ gauge railroad of about twenty five miles in length.



UNLOADING MAHOGANY LOGS FROM WAGONS



SCENE ALONG C. C. MENGEL AND BRO. CO. RAILROAD
NEAR STATION NO. 4. SHAY LOCCOMOTIVE
HAULING MAHOGANY LOGS TO HONDO RIVER

The road in many places is very steep and full of curves. Some of the grades run as high as 13¼ per cent. They use four locomotives, three of which are the Shay type geared locomotives manufactured by the Lima Locomotive Corporation of Lima, Ohio. They have one 15 ton, one 20 ton and one 32 ton all specially built for the service, with special boilers adapted for such service in a tropical country. The road is laid with 25-pound steel and is as good as the average logging road in this country, notwithstanding the difficulties they have to overcome.

Their logging season begins in December and lasts until May when the wet season sets in. It is their custom to do the major part of their logging during the dry season. C. C. Mengel & Brother Company have been operating a railroad with locomotives since 1905. Formerly they used mules and tramway, but the seasons being short in which they could operate advantageously, they changed to steam power to facilitate moving the logs during the dry season.

With the Jokesmith

This story is told to emphasize the fact that the authority of the law is not always the best means of accomplishing results:

"A good old-fashioned Pennsylvania German farmer, in Bucks County, went out into a field one day to find a foreman and a dozen men busily planting stakes upon his land and arranging preliminary work for a railway grade.

" 'Vot pizness you got yet to do dot?' inquired the farmer. 'Dis is noddings for you'.

" 'Why,' replied the foreman of the gang, 'we have the right of way. We have a paper that gives us authority to do this, all right. Read this'—producing a legal document. 'Now, turn along, an' go about your business.'

"With that the farmer ambled toward the barn. A moment later his savage bull was tearing down the field. There was no time to climb trees or scale the fence, and the foreman and his men sought safety in flight. As they ran, the foreman saw the farmer.

" 'Hey,' he shouted, 'stop this bull. Here, you, stop this bull !'

" 'Vell,' answered the farmer, 'vy don't you show dot paper to der bull, heh?' "—Philadelphia Times.

"Say mister," said the man in the upper berth to the occupant of the lower, "quit that music, will you? What do you think this is, a concert hall? The rest of us want to sleep."

"Why, the car is so stuffy," said the warbler, I was only humming a little air"—Ry. Record.

Life is one darned thing after another, Love is two darned things after each other.—From Observations of the Call Boy.

The Indicator on Locomotives

There is one point in connection with the use of the indicator on locomotives which we are persuaded is too frequently overlooked. It is too often forgotten that the boiler and the furnace are inseparable parts of a locomotive engine, and that owing to this fact, it frequently happens, and indeed is usually the case, that what would be nearly the ideal indicator diagram for a stationary engine would indicate poor results for a locomotive having the same cylinders and doing the same amount of work at the same initial pressure and speed.

The performance of a stationary engine in no way effects the economical performance of the boiler which supplies it with steam, and an indicator diagram from such an engine merely shows the performance of the engine only, indicating among other things the pressure at which steam is admitted to the cylinder, regardless of whether that pressure is economically or wastefully maintained in the boiler, the manner of using the steam in the cylinder having no effect whatever upon the economical combustion of fuel in the furnace.

With the locomotive the conditions are essentially different, because the exhaust is depended upon for the blast by which the fuel is burned and the steam kept up. It thus frequently happens that a diagram which would delight the eye of the indicator man, and which would represent to him the very acme of efficiency in that type of engine, would break the back of the locomotive fireman, and cause the engine to die on the road for lack of steam. On the other hand, a diagram which considered by itself, and solely with reference to the economical use of steam in the cylinder, would be considered a very poor one, might prove in practice to be the one giving the best economy by actual weighing of coal consumed. It may be said that for every cylinder of given dimensions, and having steam supplied to it at a given pressure, there is a certain distribution of steam which is the best one for that cylinder when doing the given amount of work. This distribution will be shown by an indicator diagram, which will represent the ideal conditions of that engine and for that work. But if the engine is a locomotive engine the effect of the exhaust upon the fire must be taken into account, and there are many things about the boiler and fire-box, and in the front end, which may have an effect on the character of the exhaust required to give the best results. The kind of coal used, the form of grate-bars, the size and number of flues, the diameter of exhaust nozzles, or the variation of the draft appliances, may materially alter the character of the blast needed to produce the most efficient combustion of fuel; and as this blast is furnished by the exhaust steam, the steam distribution and the indicator diagram representing the best possible performance will be correspondingly modified. This, of course, is no argument against the use of the indicator on locomotives, but should serve as a reminder that the indicator, like everything else, should be used only for the purpose for which it is adapted, and it certainly was never intended for the indication of boilers or fireboxes. The use of the indicator has in the past been confined mainly to engines in which the exhaust has no direct effect on fuel consumption, and the theory of the indicator has been developed by such use of it. Those who propose to use it in locomotive practice must make the proper allowances for the different conditions, and failing to do so they should not blame the indicator, and declare it to be a humbug because they fail to get satisfactory results from it.

This is a matter too frequently ignored; it should always be remembered that the best indicator diagram from a locomotive is in the nature of a compromise between the cylinders and the boiler.—Railway and Locomotive Engineering.

Work is progressing nicely on the plant of the Cremer Lumber Co. of Crossett, Arkansas, Several model cottages have been completed and others are in course of construction and work is progressing rapidly on the mill buildings. Streets have been laid off and everything seems to point to an early completion of the plant.

The Crossett Lumber Co., Crossett, Ark., is having several wells drilled near No. 2 saw mill. Two have been completed and the contractors are busy on the third one. The Clifford Well Company of Texarkana have the contracts.

NOTES FOR THE ENGINEMAN AND FIREMAN

BY F. R. WADLEIGH.*

However well a locomotive may be designed its operating economy will be low, unless it is handled intelligently and fired with care and skill. A really good fireman will effect greater economies than any apparatus on the locomotive. The effective carrying out of all plans and schemes for the economical use of fuel on locomotives comes to depend finally on the interest, co-operation and skill of the engine crew; but, upon all factors effecting fuel consumption the fireman has the greatest influence. His work can spoil or render ineffective the best coal and the most efficient design of locomotive; on his intelligence and industry depends largely the expenditure of $188,735,868.00 (paid by the railways of the United States for coal in 1909,) which is 12¾ per cent. of the total operating costs of the railways. He may, by the exercise of the utmost skill and intelligence, turn into steam 80 per cent. of the heat value of the coal, or by careless firing and ignorance, may easily waste 30 per cent. of the heat units in the coal, and only utilize 50 per cent. Of course, the quality of the coal and the design and the economical rating of the locomotive have much to do with the results obtained by the fireman, but skilful firing and handling of the locomotive can very largely neutralize poor design and overloading, just as good coal can, and is often made, to overcome the poor condition of the locomotive.

There is more coal wasted by careless firing than in any other way, and while some firemen are better than others, no man of ordinary intelligence can afford to do anything but his best. The fireman should look upon the coal as so much money entrusted to his care by his employer, to be used in the most careful and intelligent manner and from which he is to get the greatest returns. A good fireman is a skilled workman and should be ashamed to turn out poor work, just as a skilful mechanic is. The difference to the employer, in dollars and cents, between a good fireman and a poor one is certainly a great one. Anything in the way of written or printed suggestions that will help the fireman in his work will not only be of value to the man but also to his employer—the railway; it is hoped that the following suggestions, gathered from years of practical experience and study, will be of assistance to both.

The engineer and fireman should remember that all instructions are given them to think about and to find reasons for, so that they may be applied to varying conditions, as it is obviously impossible to give reasons and detailed instructions covering all points and conditions applying to fuel consumption without going into the matter at too much length. The mere giving out of such instructions is not sufficient in order to get results. The rules given should be carried out here, there and everywhere, not only on fast passenger trains but on slow freights as well. Everyone connected with the handling of locomotives should have copies of such instructions and be made to take an interest in their being carried out. The trainmaster, as well as the road foreman or traveling engineer, should be aware of the importance of the subject and should see that any firing instructions issued are carried out just as much as the train rules are.

If the railways expect their engine crews to be interested in fuel saving and insist on their carrying out reasonable and proper instructions to that end, they must keep in good condition all appliances effecting the use of fuel. It is not encouraging to a fireman to know that a hundred or more flues are stopped up on his locomotive, and that when the engineman reported "clean flues" on the work report book to find, on going out on next trip, that only the small holes have been bored through in a few bottom flues and that the rest are as bad as they were on the previous trip. It is such occurances (and they are not uncommon) that are largely responsible for the lack of interest and care shown by engine crews in the matter of fuel economy. Where one finds a road that keeps the flues clean and firebox and arch in good order, that does not have steam leaking around the piston rod and the valve stem packing, that keeps the valves square and the cylinder packing tight, there will also be found a road whose men take an interest in the fuel question.

* Fuel Engineer and Assistant General Engineer Chesapeake & Ohio Coal and Coke Company.

There are several ways in which locomotive fuel is wasted with which the engine crews have little or nothing to do. Careful tests made not long ago showed that not less than 15 per cent. of the fuel supplied to locomotives performed no part in the actual moving of trains, but was accounted for in other ways. For instance, keeping more locomotives in service than are needed by business requirements, delays in yards and at meeting points, unnecessary stops, ordering locomotives out before they are needed, carelessness in cleaning and building fires, schedules divided up without taking into consideration the grades and curvature of the road. Every 15 or 20 minutes' delay may cost from 500 to 1,000 lbs. of coal, according to the state of the weather. In fact, everyone, from the general manager to the brakeman and the wiper, each and all affect, by their methods, the coal consumption of locomotives.

DISPOSITION OF HEAT IN A LOCOMOTIVE FIREBOX

Tests on the distribution of the heat of the coal used in a locomotive, carefully made under the direction of Prof. Goss, showed the following results, a good Pennsylvania or West Virginia coal being used. (Bulletin 402, United States Geölogical survey.)

	Percentage of Total Heat in Coal. Used.	Lost.
Absorbed by water in the boiler	52	....
Absorbed by steam in the superheater	5	....
Lost in vaporizing moisture in coal		5
Lost through discharge of carbonic oxide gas		1
Lost through the heat in gases going out stack		14
Lost by unburned coal in front-end cinders		3
Lost by uncomsumed coal thrown out stack as sparks		9
Lost by partly burned coal in ashes and clinkers		4
Lost through radiation of heat by boilers and cylinders, leaks of steam, water, etc		7
	57	43

Now this statement applies to the locomotive only when running and not blowing off steam, and it does not include the coal used while standing, starting fires, and switching. Prof. Goss states that about 20 per cent. of the total locomotive fuel is used in the ways just mentioned, or is left in the firebox at the end of the run; so that the heat balance given above accounts for about 80 per cent. of the total fuel.

During the year 1906, there were 51,000 locomotives in the United States, which consumed not less than 90,000,000 tons of coal, costing the railways $170,500,000. Applying the heat uses and losses given, we get the following results.

	Tons
Consumed in starting fires, in movements in yards, going in and out of sidings, in leaks and safety valve losses, and while standing	18,000,000
Used; that is, represented by heat transmitted to water in boiler	41,040.000
Required to evaporate moisture in coal	3,600,000
Lost through incomplete combustion	720,000
Lost through heat gases going out of stack	10,080,000
Lost through cinders and sparks	8,640,000
Lost through unconsumed fuel in ash and clinkers	2,880,000
Lost through radiation, leakage, etc	5,040,000

Some of these losses—that due to moisture in the coal, the loss due to incomplete combustion, and those due to radiation and leakages, are not likely to be much reduced in ordinary locomotive work; the losses due to the heat of gases going out of the stack and those due to cinders and sparks can only be lessened by changes in the design of the locomotives, such as increased grate area, or by special appliances, such as smokebox superheaters and feed-water heaters, hollow brick arches, etc.

Greater care in the selection of the coals used and more care in their mining and preparation will tend to reduce all losses. But, after all, these ways of reducing the losses of heat in the coal are carried out, it is the engine crew that has to look out for them all, and it is to their watchfulness and skill that the greatest saving may be looked for. They can spoil the working of any design or appliance and cause good, well prepared coal to show poor results.

CLINKERS

A coal that will make bad clinkers is one of the worst propositions the firman has to contend with, and a little information as to what causes them will be of use. It takes a certain amount of heat or temperature on the fire to cause the clinkers to form from the ash of the coal. This temperature varies with different coals, but as soon as it is reached the clinker begins to form. Now this fusing point or melting point of the ash is largely determined by the kind of substances composing the ash. Some substances such as lime and iron will lower the melting point, so that a coal containing much lime or iron is sure to clinker badly, not because the iron or lime clinker or fuse themselves, but because they make the ash clinker more easily. There is, however, another item, and that is the

temperature of the fire at or near the grates. If this temperature is not as high as the melting point of the ash, then the latter will not fuse into clinkers. So, the hotter the fire and the more it is sliced and disturbed near the grates the more chance there is of having clinkers.

Recent careful tests show that some coals clinker at as low a temperature as 2,200 degrees while others do not clinker until the temperature reaches 2,900 degrees. The latter coal, one of the New River West Virginia variety, would not clinker in the ordinary firebox, as it is very seldom that the heat reaches over 2,400 degrees. On the Pennsylvania locomotive tests at St. Louis, where most careful measurements were made, the heat in the firebox when working light ran from 1,400 to 2,000 degrees, while when working hard it ran between 2,100 and 2,300 degrees, the highest being 2,339. It is not always the coal making the most clinkers that will cause the most trouble, as it may make a large amount of light porous clinker that can be easily broken up and will not stick to the grates, while another coal may make a comparatively small amount of thin, glassy clinker that sticks to the grates and stops them up and cannot be removed until it gets cold.

The way in which the firing is done often has much to do with clinkering; the man that carries a very heavy fire and is continually digging holes in it, thus getting green coal on the grates, turning the fire upside down and bringing the ash up into the hottest part of the fire, will certainly have more trouble than the man who is satisfied to let the ash alone where it belongs, on the grates, and who only hooks the fire to level the top of it. Another frequent source of trouble from clinkers is due to not building up the fire properly before starting.

IMPURITIES IN THE COAL

The fireman should learn to know by their appearance the different impurities to be found in coal, such as slate, bone, iron pyrites, fire-clay, etc. Knowledge of these impurities is of value, as by throwing them aside better results may be obtained from the coal and less ash and clinkers be produced. The effect of the different impurities on the burning of the coal should be watched, as all such knowledge tends to more economical results. There is, of course, a vast difference among different coals in the amounts of such impurities; some coals are apt to have considerable slate, others slate and bone, etc., this difference being mainly caused by lack of proper preparation and inspection by mine operator.

APPEARANCE OF IMPURITIES AND THEIR EFFECT ON THE FIRE.

Slates are of irregular shape, generally more or less flat and are heavier and harder than the coal and vary in size. Their color runs from a light gray to black. Some of them are soft and easily broken, while others are very hard. Their effect on the fire is to add to the amount of ash and refuse; they take up space on the grates that would otherwise be occupied by coal and also add to the size of clinkers. Slates have no value as fuel.

Bone may be called a slaty coal or a carbonaceous slate. It is really an impure coal and the slate in it is not in layers but in small particles mixed with the coal. It is harder and heavier than coal, of a darker color, and breaks into irregular shaped pieces. Sometimes it will be found in small pieces separate from the good coal and sometimes it shows in a layer in a large lump just as it comes from the seam of coal. It is usually from ½ to 4 or 5 inches thick. Its only effect on the fire is to add to the amount of ash and to take the place of better fuel, but it will not clinker. It has considerable fuel value, varying in this respect; the harder it is the less fuel value it has. Analysis shows that it contains from 15 to 25 per cent. ash while the good coal will not have over 7 per cent.

Fire clays exist in small pieces or layers in the coal, soft, like putty and are generally of a light gray or reddish gray color. They are usually found below the seam of coal, but sometimes in the middle in thin layers. They add to the amount of ash and clinkers and have no value as fuel.

Iron pyrite is a bright yellow color, resembling gold or brass, coming sometimes in thin layers or flakes and sometimes in hard round, or partly round, balls often in chunks more or less mixed with other substances. It is composed of iron and sulphur and not only has no practical value but also is one of the main causes of clinkering, due to the iron it contains. Some coals contain very little pyrites, only

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Rating a Locomotive

(Concluded from page 2)

which is the tractive power at twenty miles per hour.

Taking up the horse power formula and substituting known quantities found, we have:

$$\frac{9572 \times 20}{375} = 510$$

horsepower of the locomotive at twenty miles per hour.

In these calculations it will be noticed that speed is a vital factor in determining the horsepower of a locomotive as well as the capacity of the boiler, and while these same elements effect the calculations of tractive power to a certain extent, the most intelligent method of rating locomotives is by tractive power and tons hauled after deducting resistance due to internal and rolling friction, grades, curvature, etc.

Notes for the Engineman and Fireman

(Continued from page 9)

a few flakes occasionally on the surfaces of the lumps, while other coals are full of it.

A form of lime is found on the surface of the lumps of some coals, and is of a whitish brown color. It is responsible for considerable trouble when it occurs in any large quantities, as it makes the ordinary ash fuse or run together, making a sticky, pasty clinker that runs into the spaces between the grates and stops them up. Good coals usually contain little or no lime, while some coals are almost covered with it.

WETTING COAL BEFORE FIRING

The wetting of coal is such a universal practice on locomotives, as well as at many stationary plants, that a little information of the subject, which is not often discussed in books, may be of value. In the first place, coal will always be wet down on locomotives in order to keep dust from flying about, as a matter of comfort to the men on the engine, if for no other reason.

It is claimed by many chemists and engineers that coal should not be wet because:

First—Any moisture or water in the coal must be evaporated in the firebox, which wastes heat; the water must be raised to a heat of 212 degrees, when it is evaporated into steam, and this steam must be raised to the heat of the gases in the firebox.

Second—That water in the coal is turned into steam which takes up valuable space in the firebox that would otherwise be occupied by the hot gases from the coal, and this reduces the draft. The steam from a given quantity of water takes up nearly 1,600 times the space or volume that the water did at the ordinary pressure and temperature of the atmosphere.

Third—That if the water is separated by heat into oxygen and hydrogen, their combustion gives no gain, as the heat it takes to separate them is just as much as will be gained by burning them.

On the other hand, the reasons given for wetting coal may be summed up as follows:

First—The comfort of the men on the engine.

Second—The coal is held together, especially if there is much slack, which prevents fine coal from being drawn out though the flues before it touches the fire, and if a coking soft coal is used, it will coke more readily and make a better fire.

Third—Water vapor or steam in the firebox promotes combustion. lengthens the blue flame of the burning hydrogen and carbonic oxide gases, and the heat from burning these two gases more than makes up for the heat lost at first by separating the oxygen and hydrogen of the water.

Fourth—It keeps down the smoke by making the coal burn slower, giving the gases a better chance to mix with the air. When coal is first thrown on the fire it gives off at once a large amount of hydro-carbon gases (composed of hydrogen and carbon,) which are usually given off faster than they can be brought into contact with the necessary amount of air for complete combustion. Now, if by wetting the coal we can hold back this gas a little, an advantage will be certainly gained by the burning of this gas, which is high in heating power, and some of which would otherwise pass out of the firebox unconsumed and make smoke.

Fifth—It prevents the loss of fine coal dust, which if dry, would be blown away or lost by the shaking of the locomotive.

The writer knows of no actual reliable tests made on locomotives to settle this question.

G. H. Barrus, in his book, "Boiler Tests," gives the following information:

"In running a test on a double-deck horizontal return tubular boiler, using George Creek Cumberland coal, an amount of water equalling 5 per cent. of the weight of the coal used was added to the coal before firing, the result showing an increase in evaporation of 3 per cent. as compared with a test made on the day previous with dry coal. The coal used contained 6.7 per cent. ash."

G. R. Henderson, in his work on "Locomotive Operation," says:

"The practice of wetting coal is due to an effort to keep down the dust and also prevent the dry, fine stuff passing to the stack without being consumed—in this it is effective, but no more water should be used than necessary to effect this purpose, as all such water must be evaporated in the firebox and absorbs otherwise useful heat."

It is believed therefore that, apart from the question of comfort of the engine crew, it is a good practice to always wet the coal, so that it goes into the firebox moist, but not dripping wet. It may be stated here that there is quite a widespread idea among enginemen and firemen that wetting some coals will cause them to clinker. This idea is a wrong one. The only effect that wetting coal might have on clinkering would be to prevent its formation or to make it less troublesome. It is a common practice in stationary plants to blow steam under the grates to prevent clinkers and also they keep the ash pit full of water, partly for the same purpose.

FIRING LOCOMOTIVES WITH MIXED COAL

It frequently happens that more than one kind of coal must be used on locomotives on the same division or run. This is a matter over which the engine crews have no control, of course, but is is responsible for a large amount of trouble and reports of "poor coal." It should be the practice on every road to avoid, as far as possible, any mixing of coals on any one division. Coals of the same appearance and nature—two different coking or semi-bituminous coals, such as Pocahontas and New River, or two different gas coals such as Fairmont and Tennessee or Kanawha gas and Splint—will usually burn when mixed without any trouble, but the coals of a different nature are very apt to give trouble from clinkers when mixed. Besides locomotives are drafted for one coal and consequently do not give good results with another coal. When coals of a different nature are used, such as a gas and a coking coal, different methods of firing are required.

That this mixing of coals is often detrimental to good results was shown some years ago on the Chicago & Northwestern, when a remakrable improvement in engine performance was gained by a change in distribution of coals, so that each principal division was given one kind of coal exclusively. Whatever the mixture may be the fireman should learn the difference between the coals, both in appearance and in their burning and how the mixture can best be burned.

CLEAN FLUES ON LOCOMOTIVES

The importance of having clean flues can hardly be overestimated; and by clean flues is is not meant the boring out of a hole through the flues, but a thorough cleaning, so that the inner surface of the flue is directly exposed to the flame and gases from the firebox. Dirty flues not only obstruct the draft, but also lower the amount of heat that can be transmitted to the water from the fire. It is likely that a large number of engine failures charged to poor coal were really due to stopped up flues. Before reporting the locomotive as needing a change in the draft by either moving the diaphragm or changing the size of nozzle or blaming the coal or the fireman, the engineman should always be sure that the flues have been thoroughly cleaned.

"Clean flues will put a lot of lump in a bad tenderful of slack." Yet cleaning of flues, one of the most important requirements about a locomotive, is neglected at most engine houses more than anything else about the engine. If locomotive flues were kept as clean and were cleaned as often as the flues in the average stationary boiler or in marine boilers, 50 per cent. of the failures would not be due to lack of steam, and the amount of coal used would be greatly reduced.

In any ordinary plant the flues are cleaned out with steam at boiler pressure at least once a day, and where they run in 8-hour shifts, on each shift. On board ship they are cleaned out usually on each watch. Locomotive flues should be cleaned out at the end of each trip

with a blower, whether reported or not; the extra cost would be more than made up by more steam with less coal used. It is not uncommon to find a hundred or more flues more or less stopped up. The writer has lately seen a case on a large road where 242 flues needed cleaning on a passenger locomotive that was giving trouble and having delays on account of no steam, and the trouble was blamed on the coal. After the flues were cleaned the same tender of coal made more than enough steam, and much less coal was burned. The engine crew should watch the flues closely and try to have them cleaned as often as possible.

MAINTAINING STEAM PRESSURE

The steam pressure should be allowed to vary as little as possible and the fireman should see that there is no change due to any inattention, carelessness or laziness on his part. When the steam pressure changes either way and the position of the reverse lever, the injector and the throttle are not changed and the speed is the same, the cause of such change must be due to a change in the condition of the fire, and the fireman should always try to find out what that change is. To do this he must watch the fire closely all over and see its exact condition, especially around the sides and ends of firebox. Variations in pressure are not only hard on the boiler and firebox, owing to unequal expansion and contraction caused by the change in heat on the outside and inside of the firebox sheets and flues which tends to make the flues leak, the sheets to crack and the staybolts to break, but such variations are also the cause of a waste of coal, as it will always take more coal and labor to raise the steam pressure than it would have taken to have kept the steam up.

Many firemen will put the same amount of coal on the fire at the same intervals regardless of the pressure. This is all wrong; firing should be regulated not only by the condition of the fire, but also by the pressure. It is not good firing to put in the same amount of coal when steam is at blowing-off point or is blowing off, yet it is often done by firemen who should know better. The position and lighting of the steam gauge are often responsible for the uneven pressures, as the gauge is sometimes placed in such a position that the figures cannot be readily distinguished by the fireman, especially at night. The gauge should always be placed and lighted so that the figures can easily be seen from the regular places of both the engineman and fireman. —Railway Age Gazette.

Betterments on Western Railroads

Twenty-five thousand men will be required by Western roads to carry out betterment plans formulated by these companies. A good percentage of the men will be required in and around Chicago. The work to be started, already begun in some instances, includes extensions of track, additional terminals, new yards and second track on single track lines.

Probably the biggest single order for men comes from the Burlington, which will use half the total number. This company will start work in a few weeks on the last stretch of its Power River line, 106 miles, to complete its north and south route between the north Pacific coast and the Gulf of Mexico. Work was suspended last Fall on account of lack of men. The same company will also place an army or workers on the Mississippi River division of its Chieago-St. Paul line. This road is being double trackcd. —Railway Record.

Exports to South America

The total value of exports from the United States to South America for the fiscal year ended June 30, are expected to reach the record figures of $135,000,000, compared with $109,000,000, in 1911. Trade with the southern continent has shown a phenomenal gain, having more than doubled since 1905, according to figures compiled by the department of commerce and labor.

Argentina shown the largest gain in exports to South America, with a total for the present fiscal year of about $55,000,000, compared with $23,500,000 in 1905. A huge gain has also been made by Brazil. The increase in exports to these countries is especially notable in lumber, leather, mineral oils and railway material.

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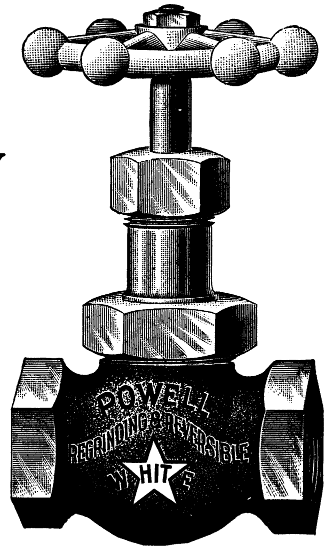

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